Advances in the chemical vapor deposition (CVD) of Tantalum

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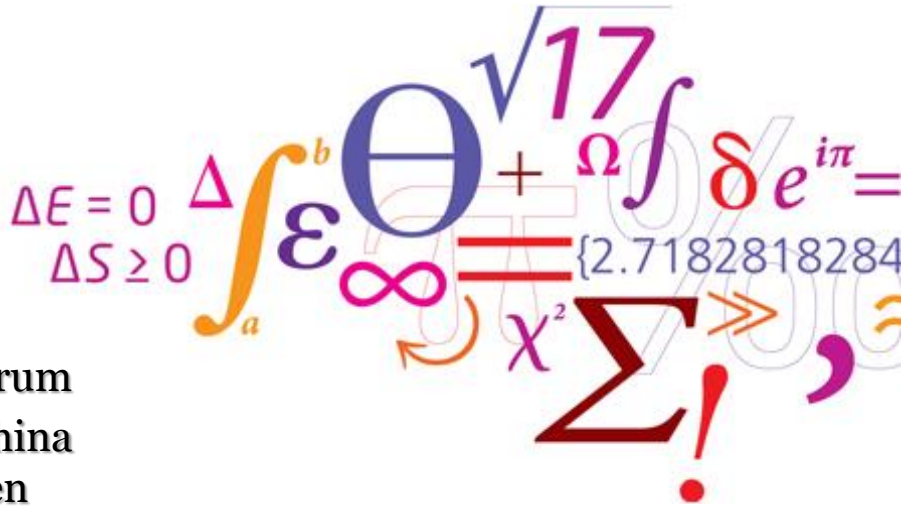
2014

CHEMICAL VAPOUR DEPOSITION (CVD) OF TANTALUM

- In Long narrow channels



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Irina Petrushina
Søren Eriksen
Erik Christensen

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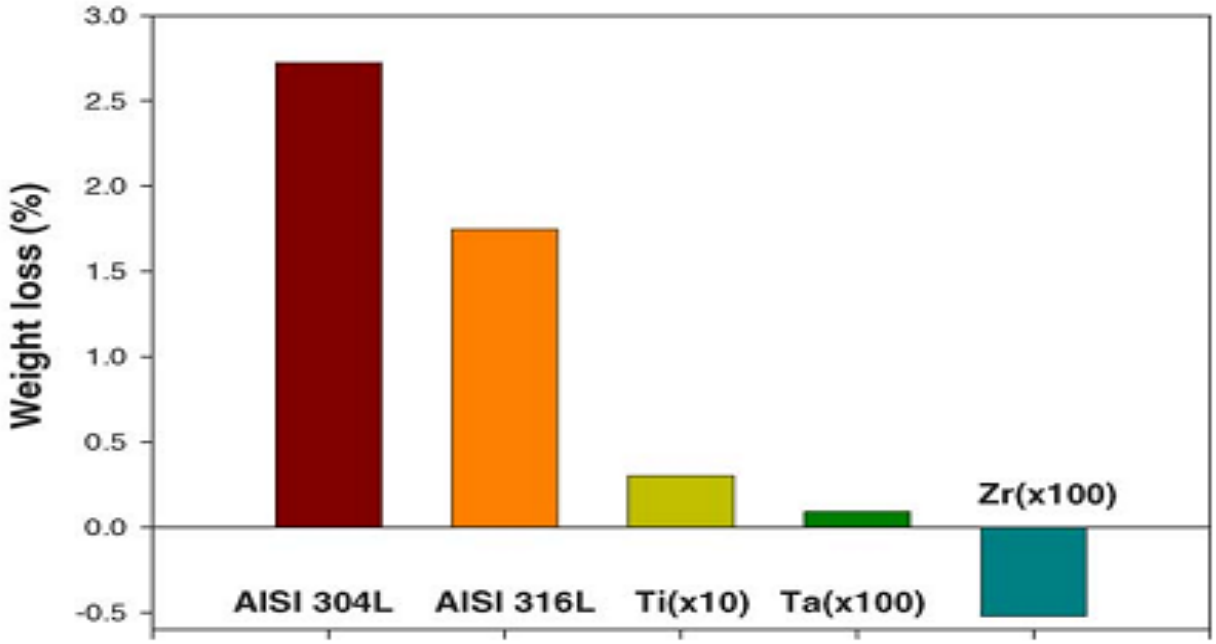
Department of Energy Conversion and Storage

Why Tantalum?

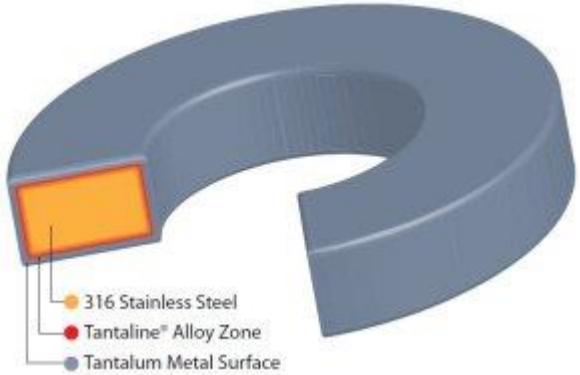


Percentage Weight loss in 10 wt % HCl, room temperature, α-alumina abrasives and 1000 rpm for 168 hours.

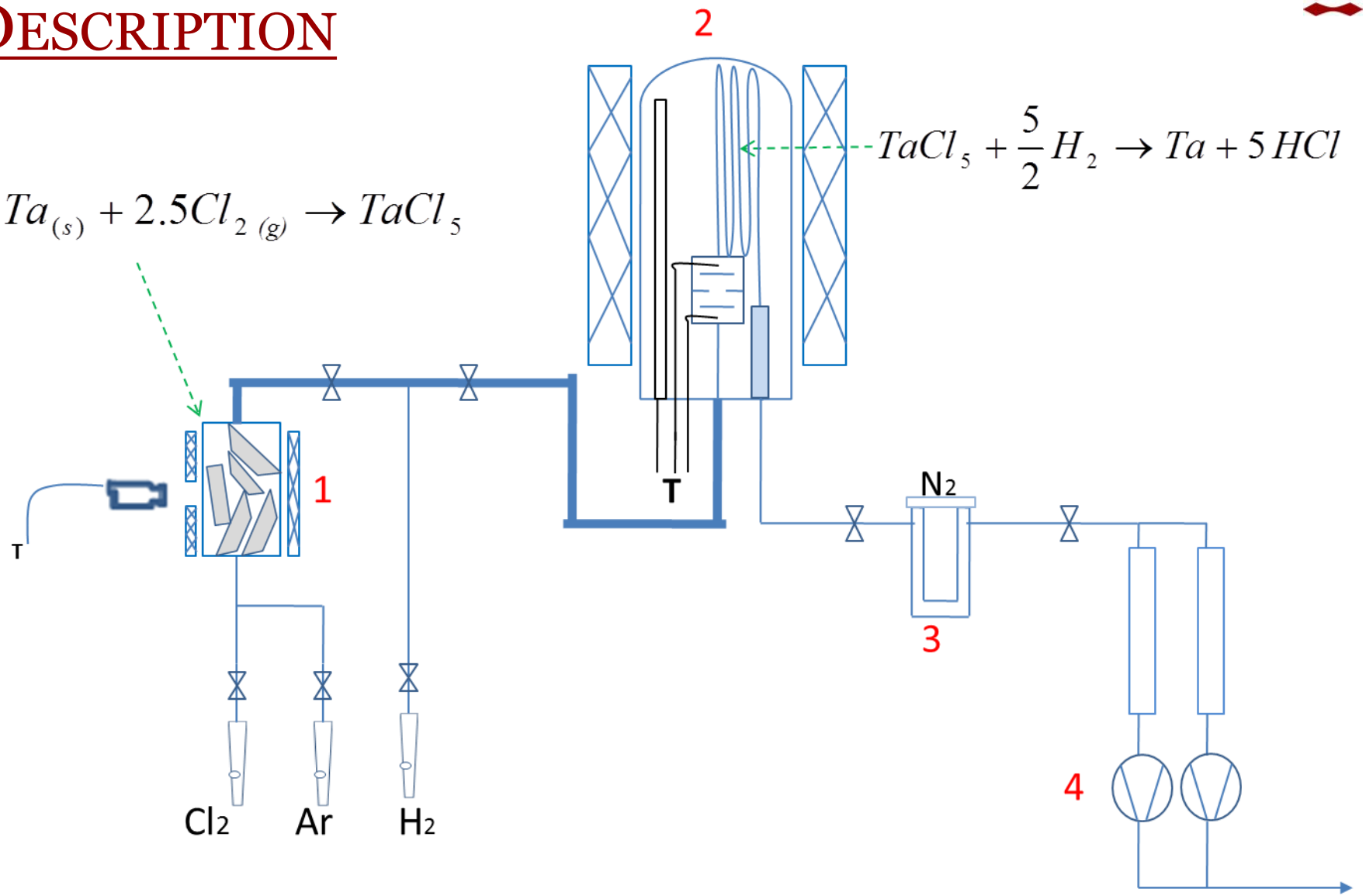
Erosion-corrosion of stainless steels, titanium, tantalum and zirconium. **Bermudez, Maria-Dolores, et al.** Cartagena : Elsevier, 2004.

Tantalum Coated Plate Heat Exchanger

TANTALINE



System Description



Modeling

Long narrow Channel: Tubes

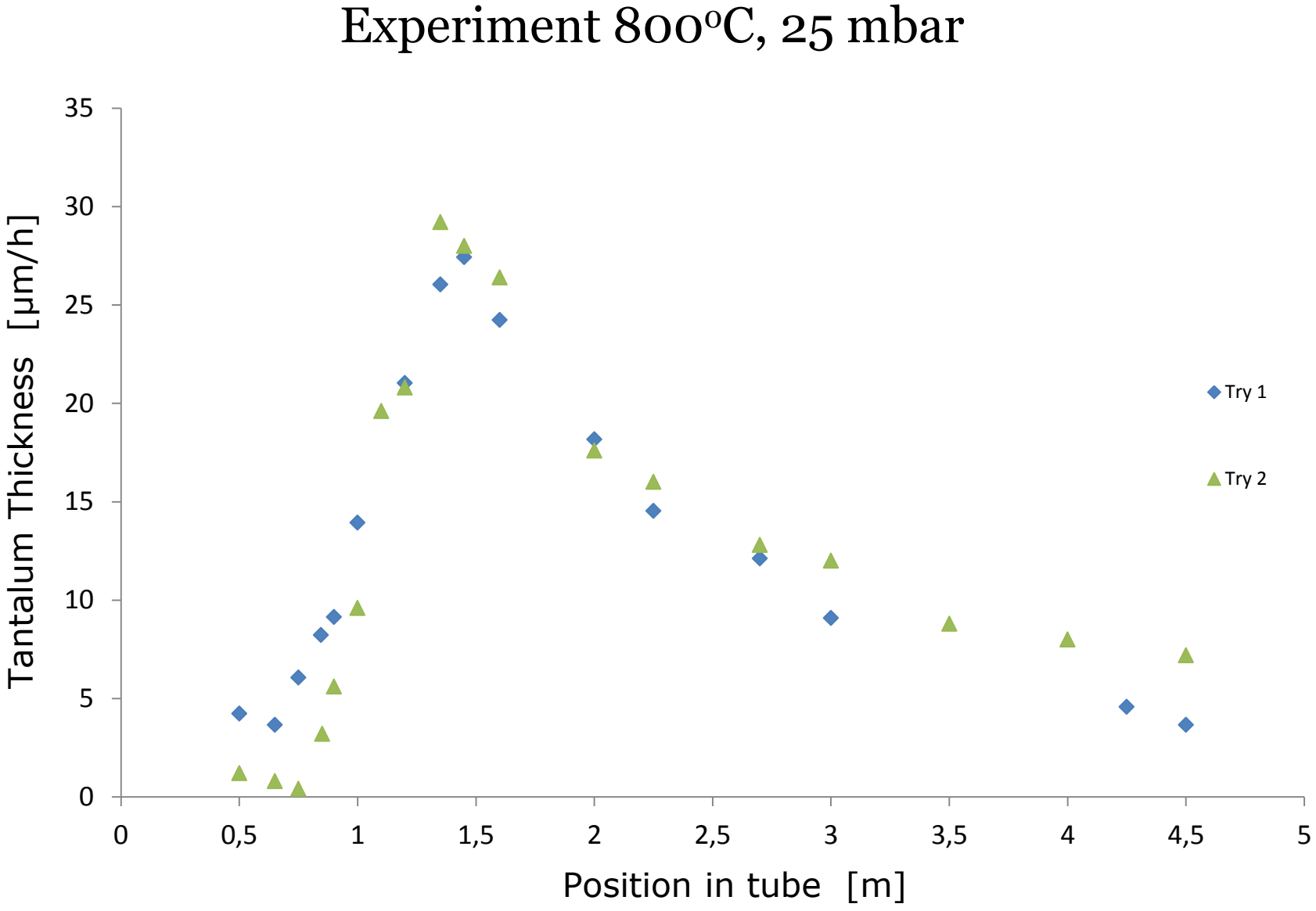
Fluid Flow: Navier Stokes

Diffusion: Fick's Law

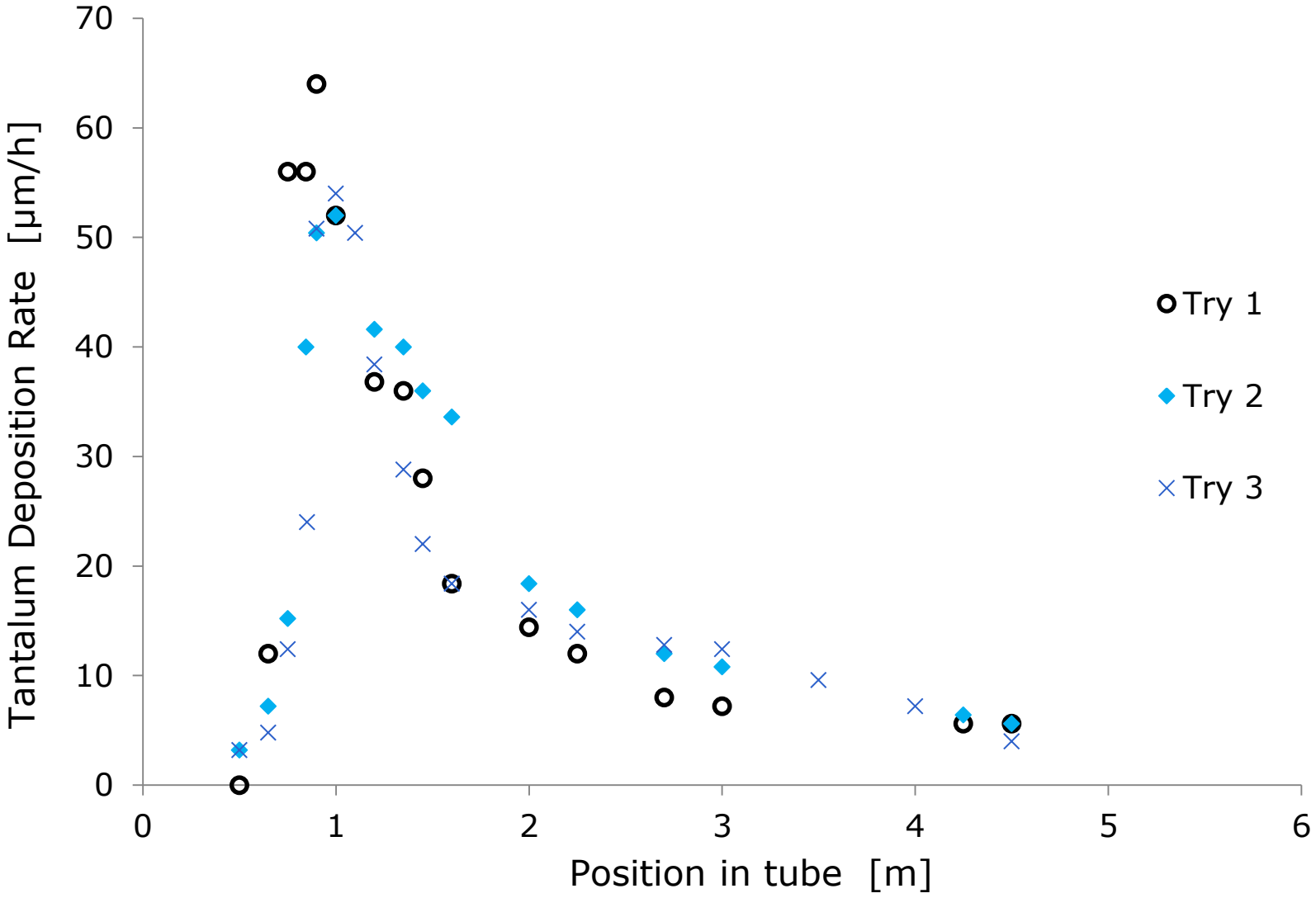
Chemical Reaction: Arrhenius

Adsorption: Langmuir

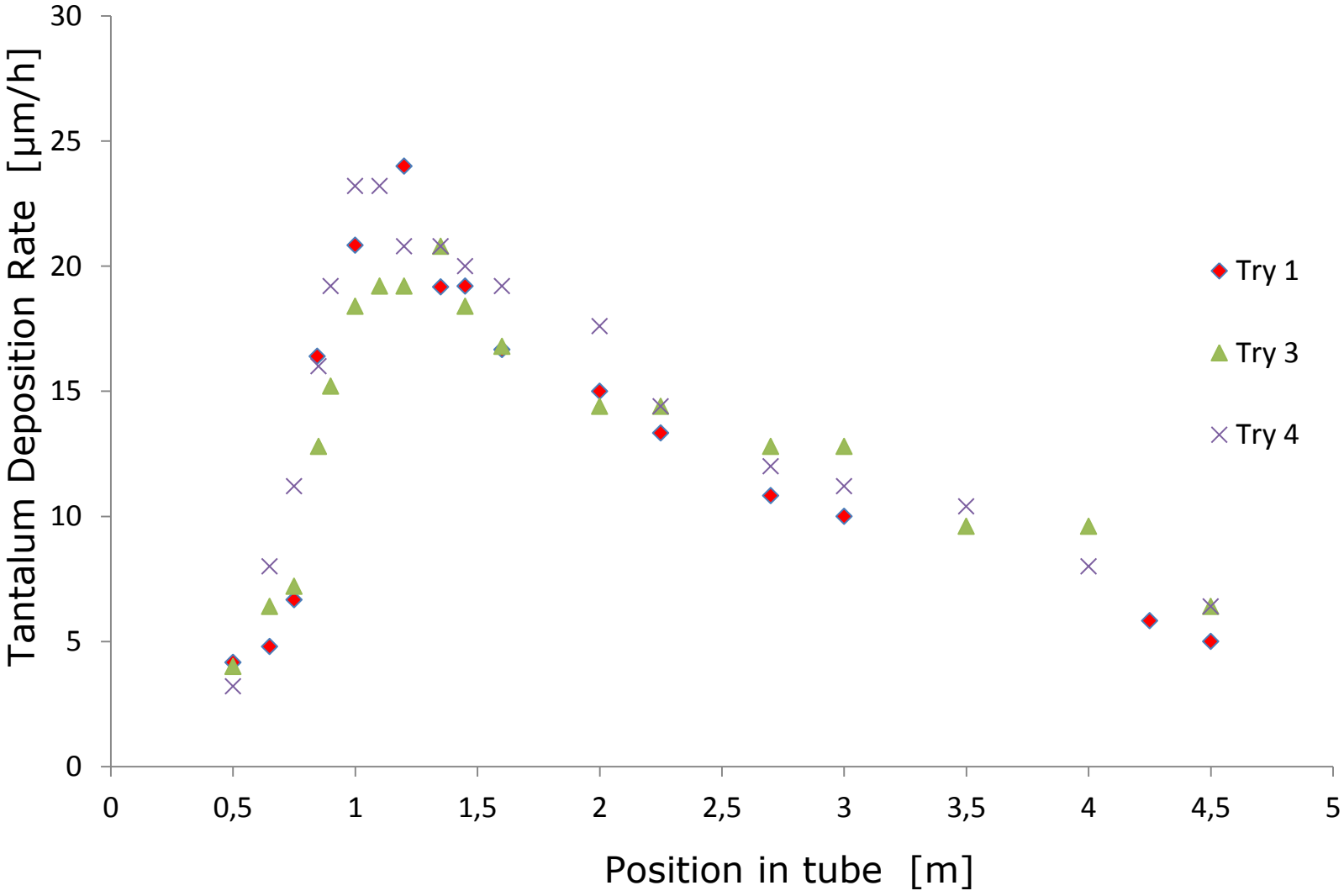
Results:


Experiment 800°C, 25 mbar
Tantalum Thickness [µm/h]
Position in tube [m]
Try 1
Try 2
0
5
10
15
20
25
30
35
0
0,5
1
1,5
2
2,5
3
3,5
4
4,5
5

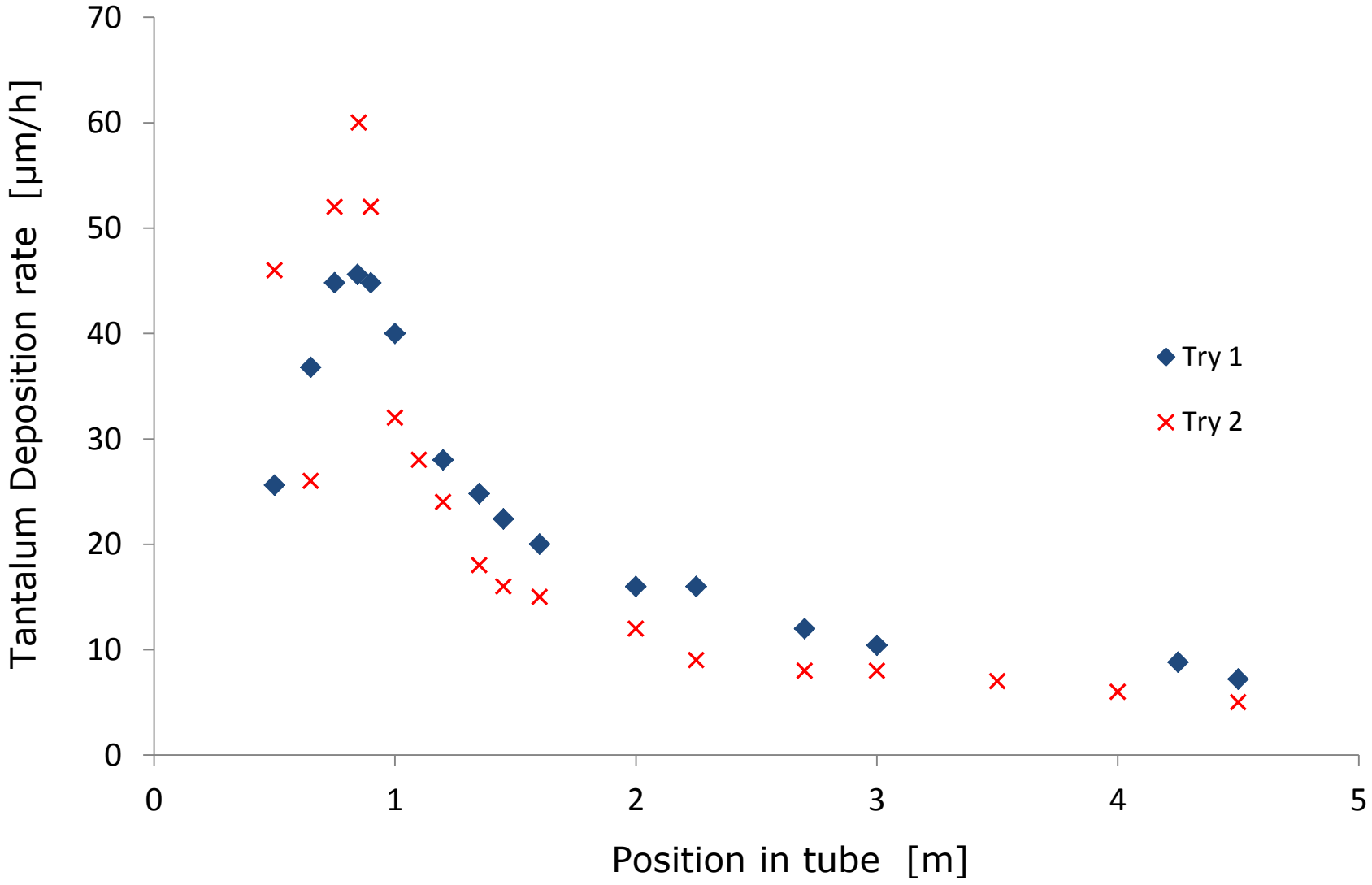
Experiment 850°C, 25 mbar



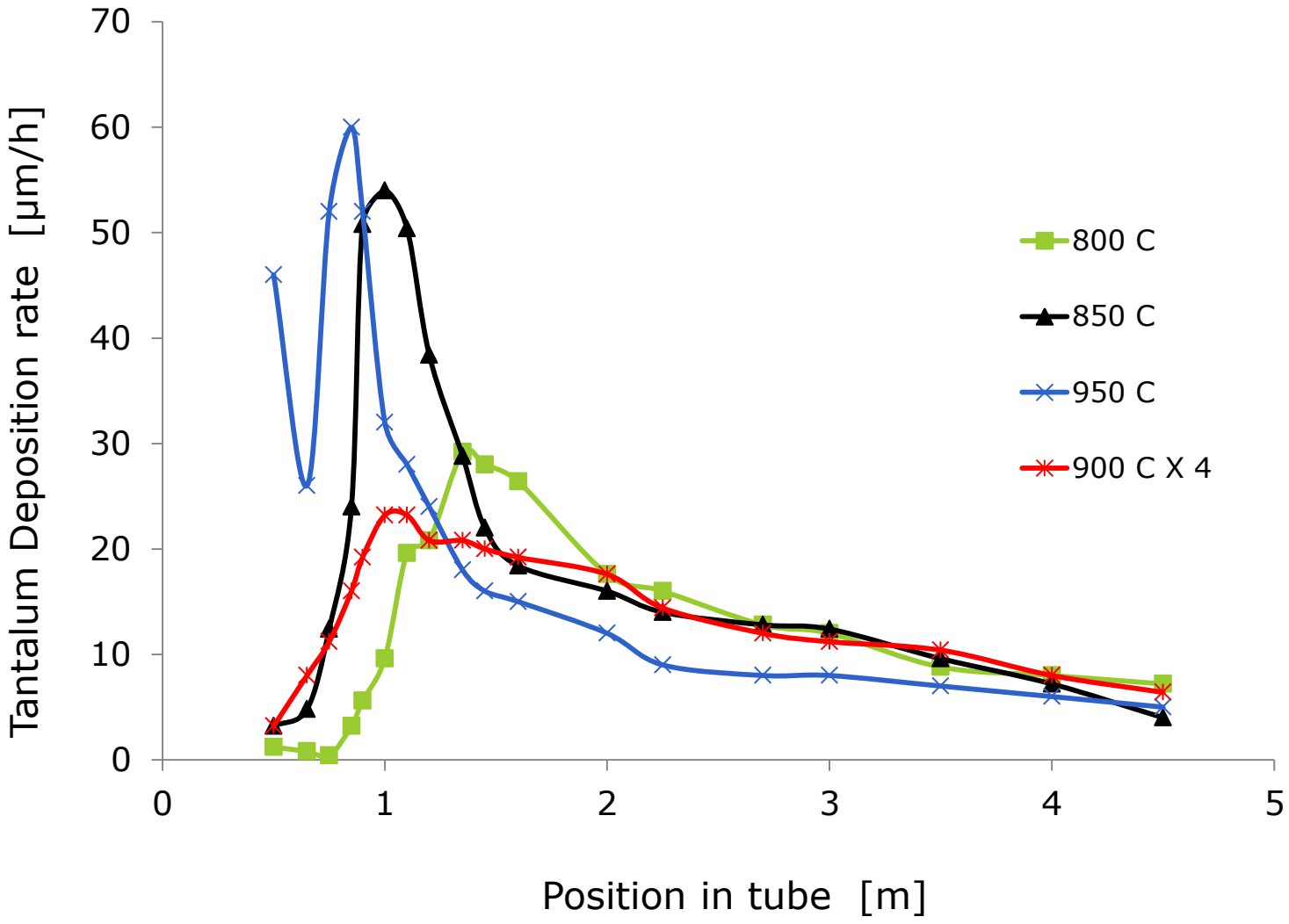
Experiment 900°C, 25 mbar



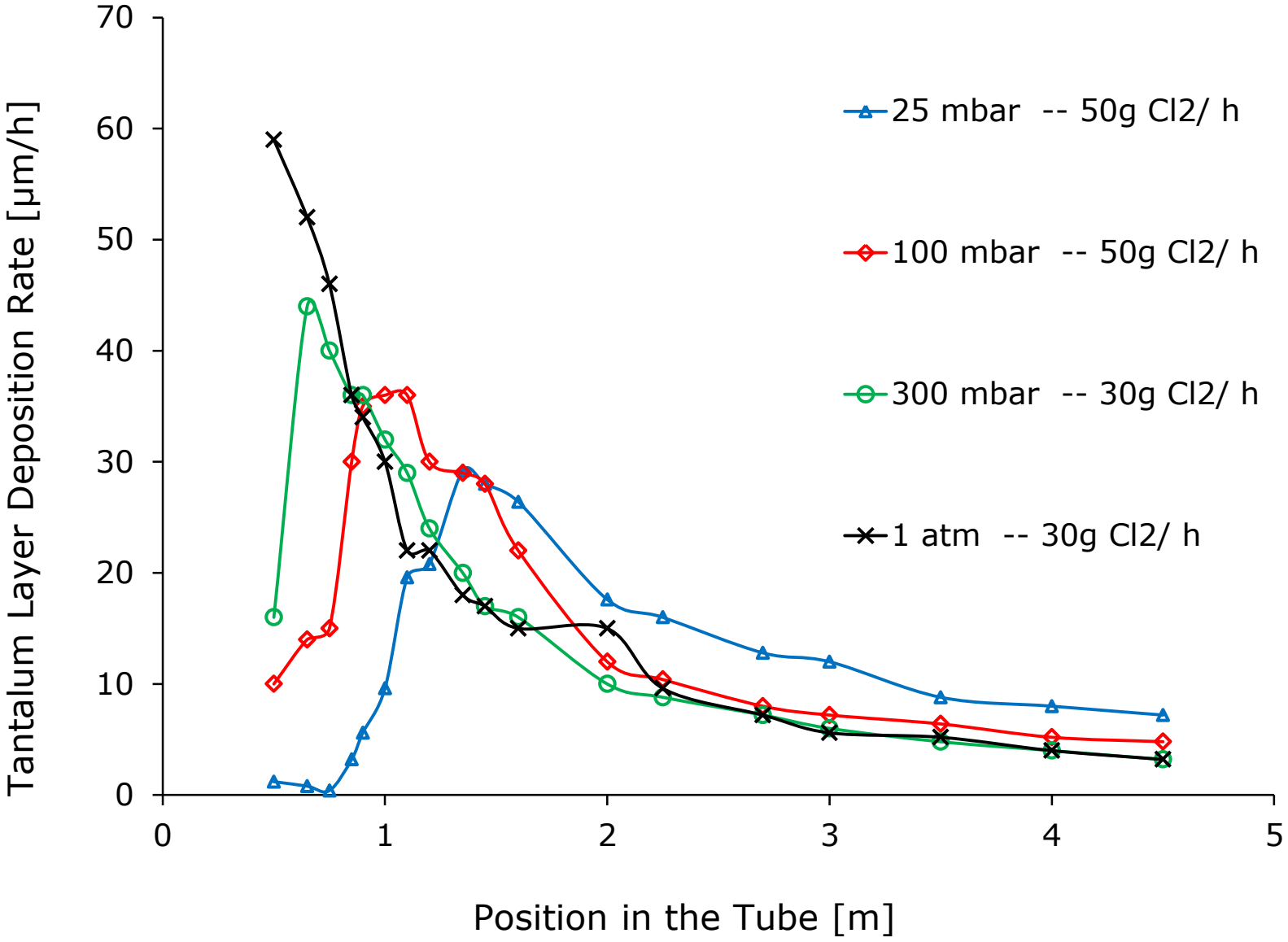
Experiment 950°C, 25 mbar

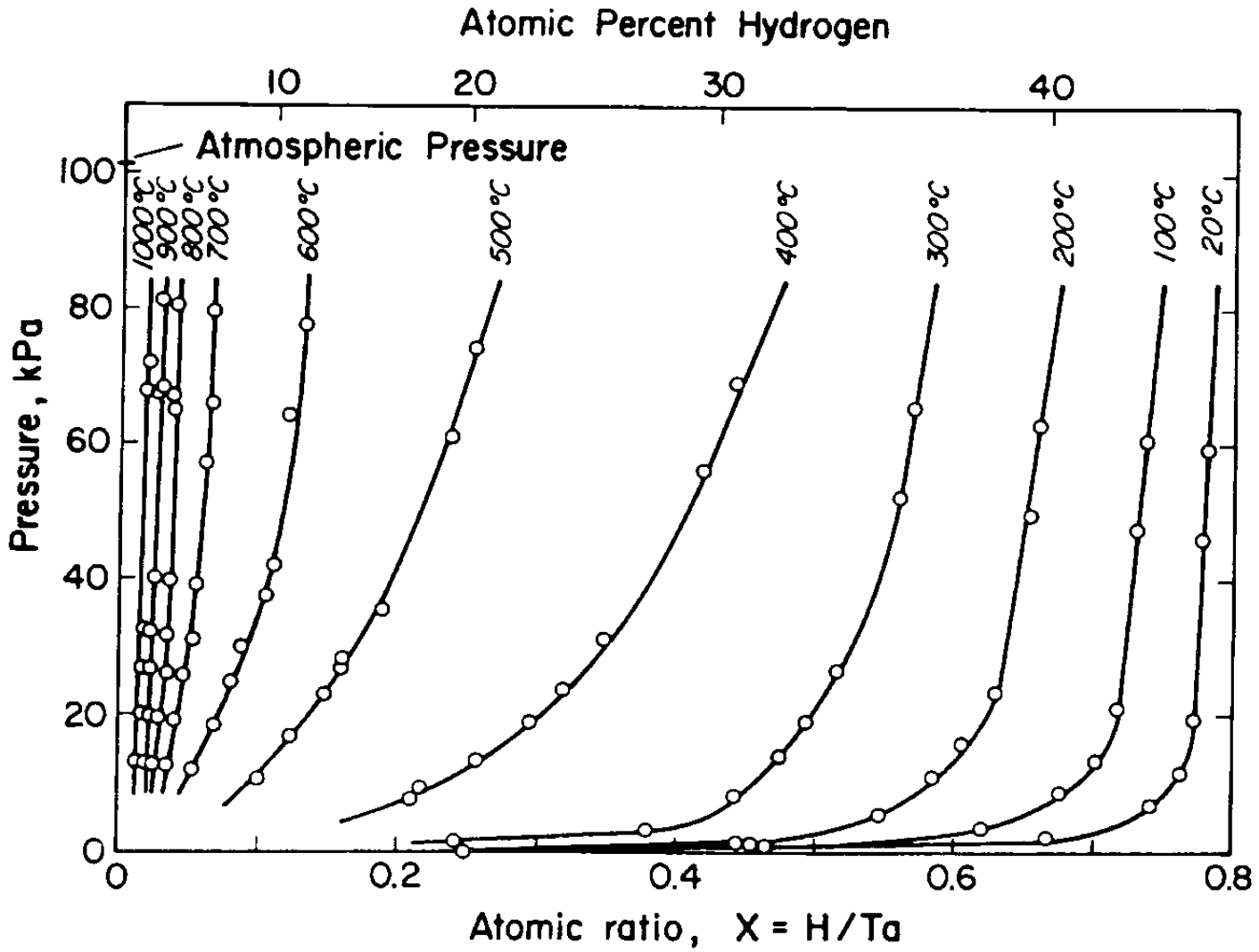


All Temperatures, 25 mbar



All Pressures, 800 °C





F. D. Manchester, Phase Diagrams of Binary Hydrogen Alloys, ASM International, 2000.

Model Fitting

Model

Fluid Flow: Navier Stokes

Diffusion: Fick's Law

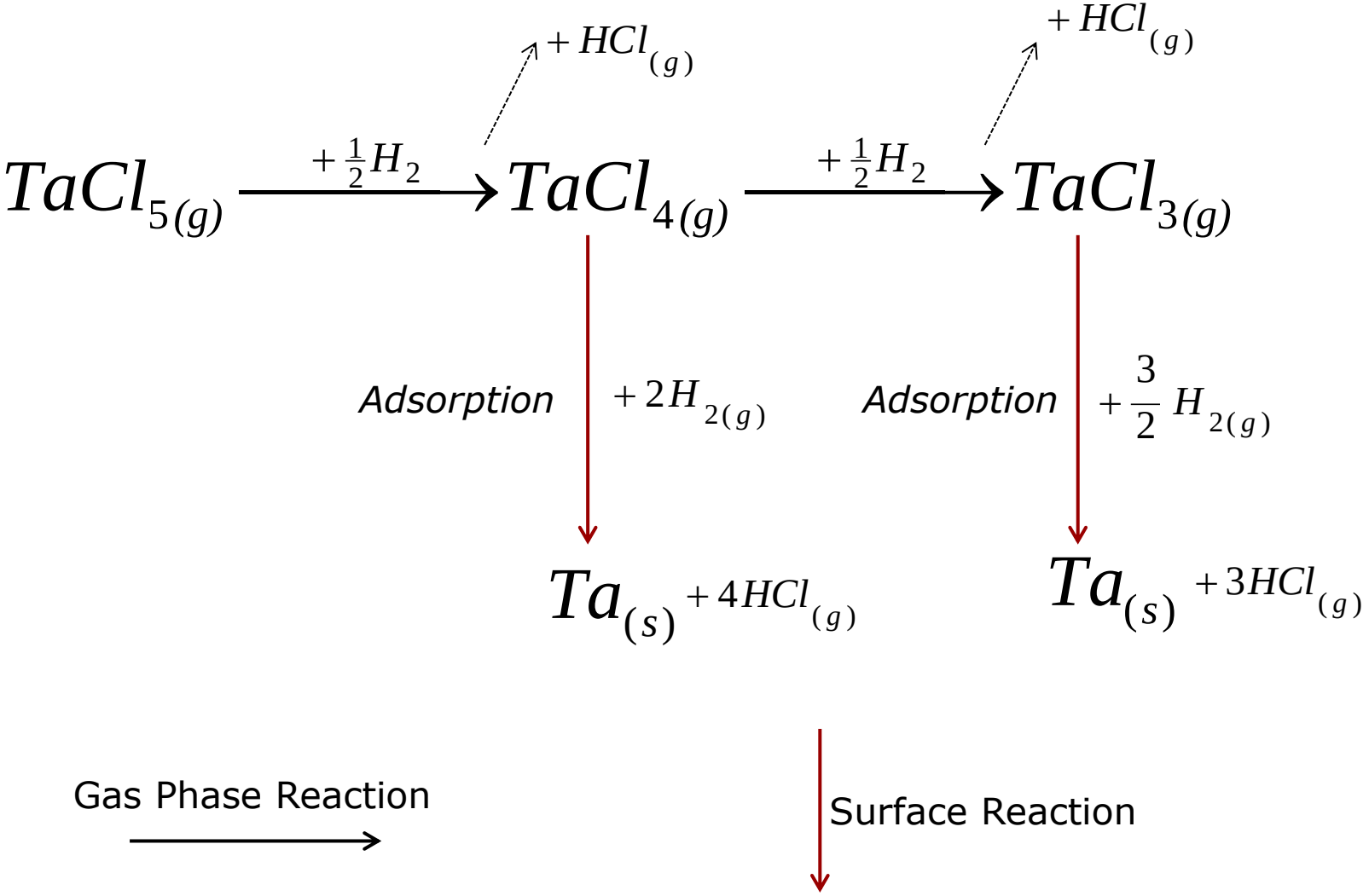
Adsorption: Langmuir

Chemical Reaction: Arrhenius

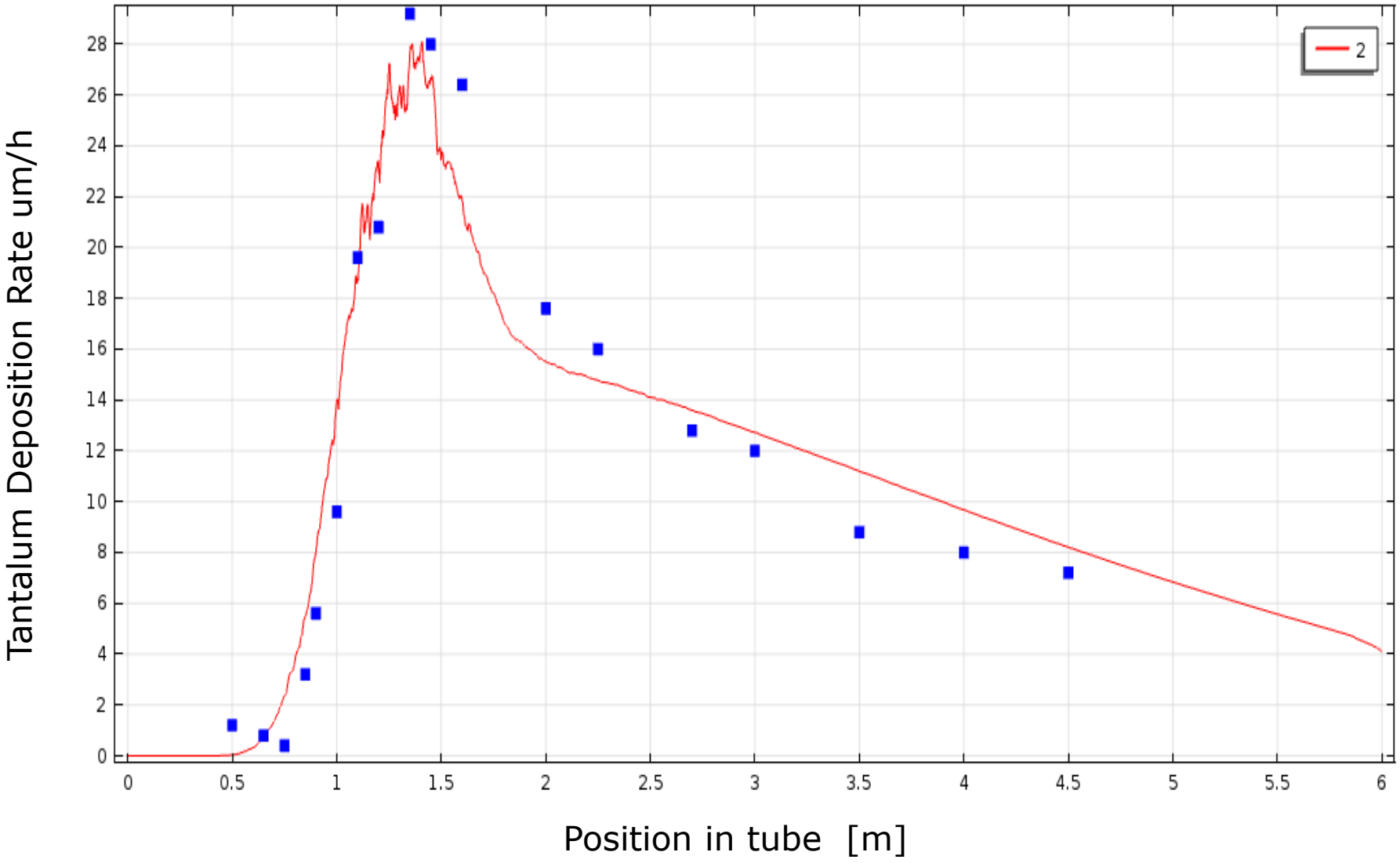
Geometry: 2D Axial Symmetry and 3D

Software: COMSOL MultiPhysics®

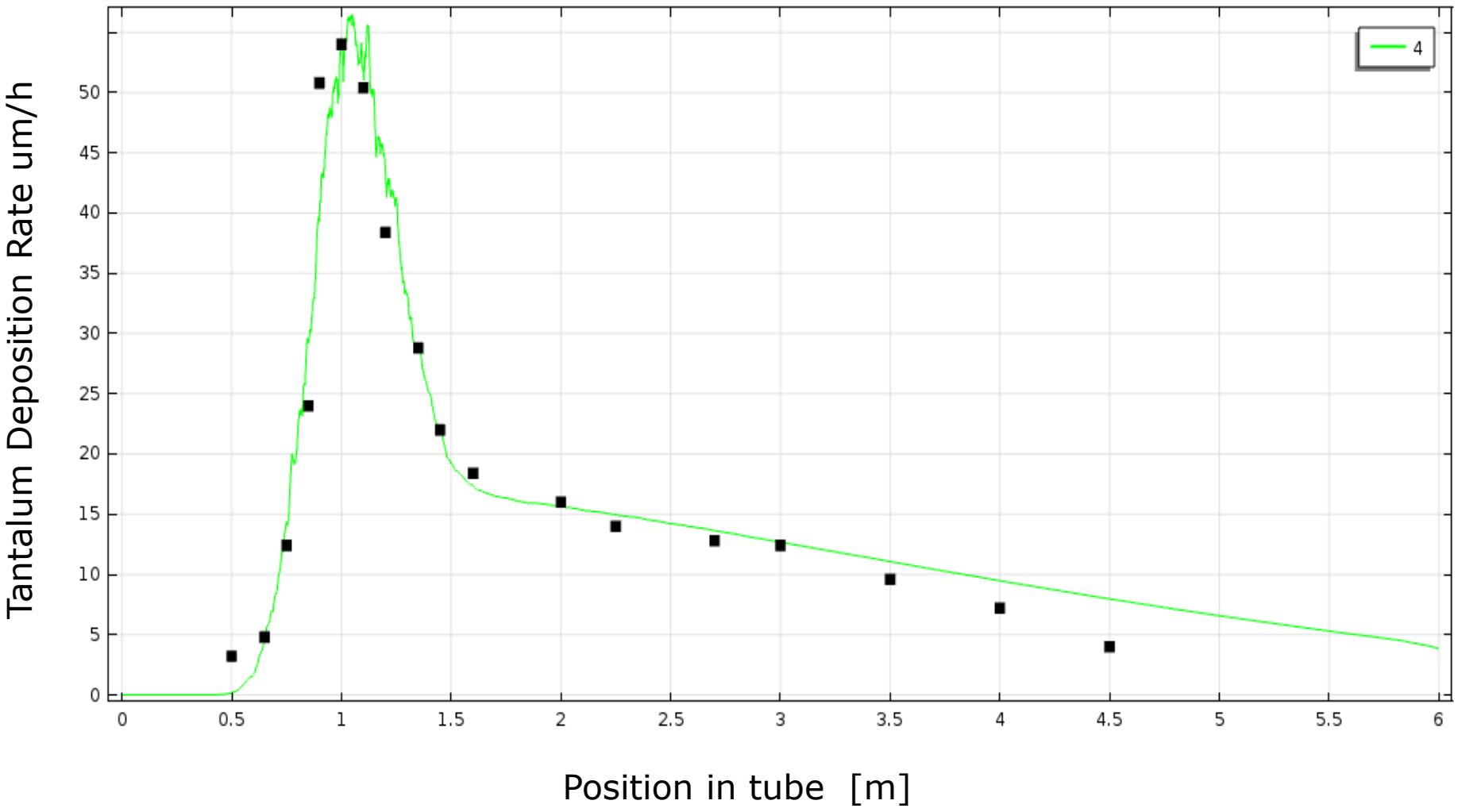
Mechanism


$TaCl_{5(g)}$
$+\frac{1}{2}H_2$
$+HCl_{(g)}$
$TaCl_{4(g)}$
$+\frac{1}{2}H_2$
$+HCl_{(g)}$
$TaCl_{3(g)}$
Adsorption
$+2H_{2(g)}$
Adsorption
$+\frac{3}{2}H_{2(g)}$
$Ta_{(s)} + 4HCl_{(g)}$
$Ta_{(s)} + 3HCl_{(g)}$
Gas Phase Reaction
Surface Reaction

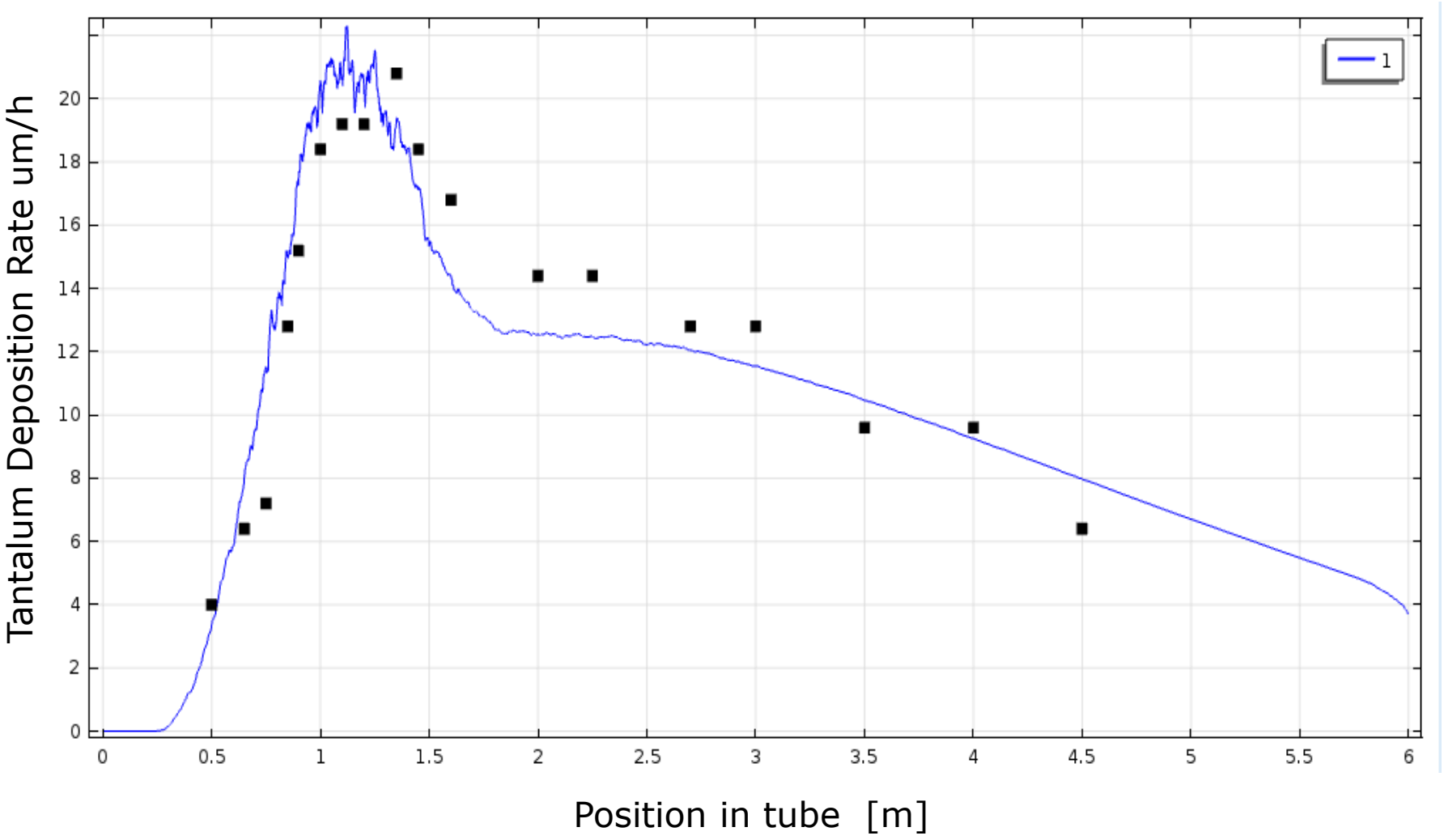
Model Fitting – 800 °C



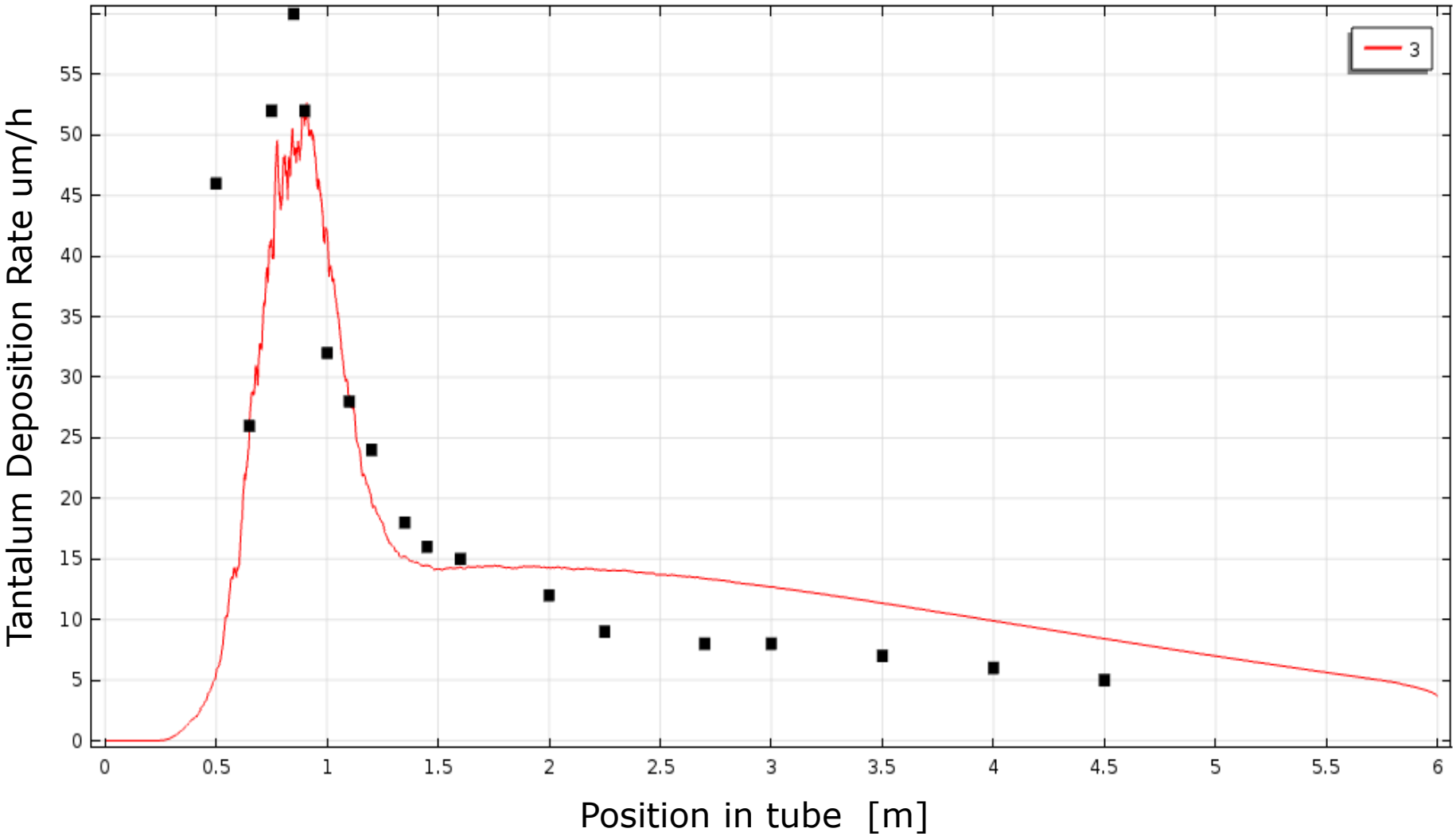
Model Fitting – 850 °C



Model Fitting – 900 ^{O}C

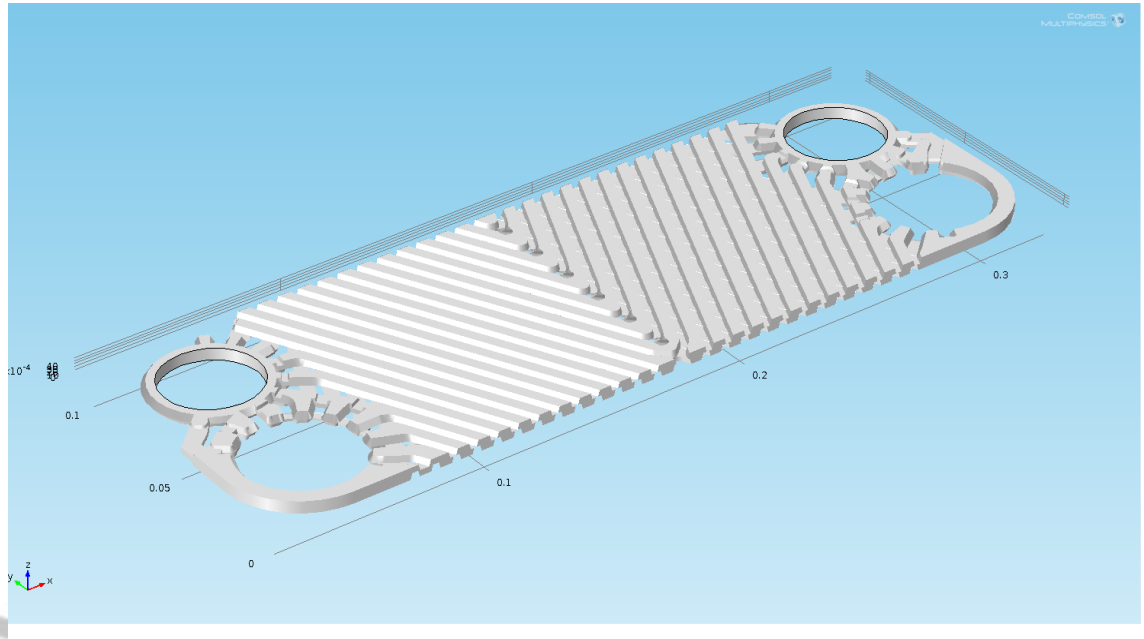


Model Fitting – 950 ^{O}C

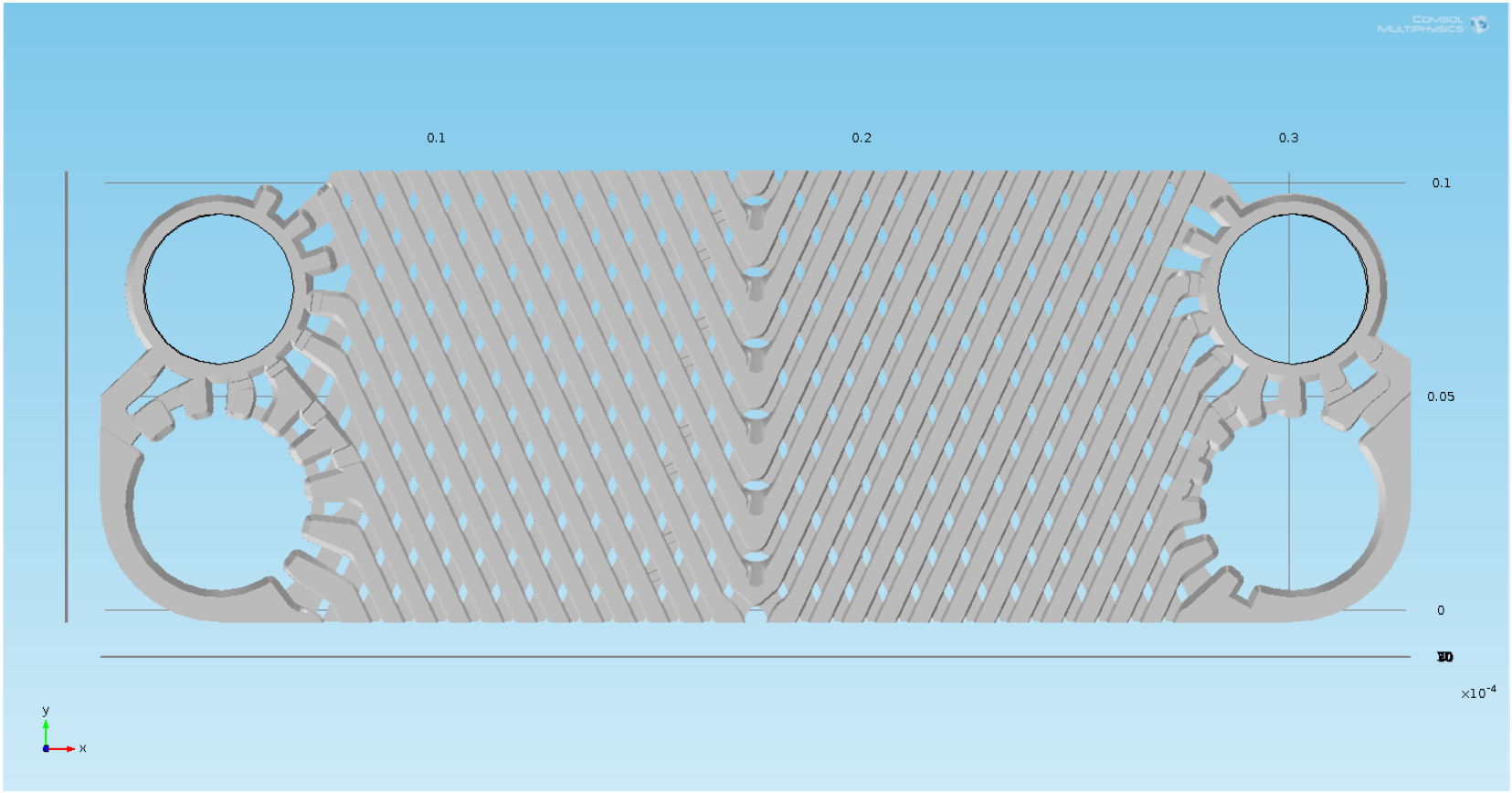


Application

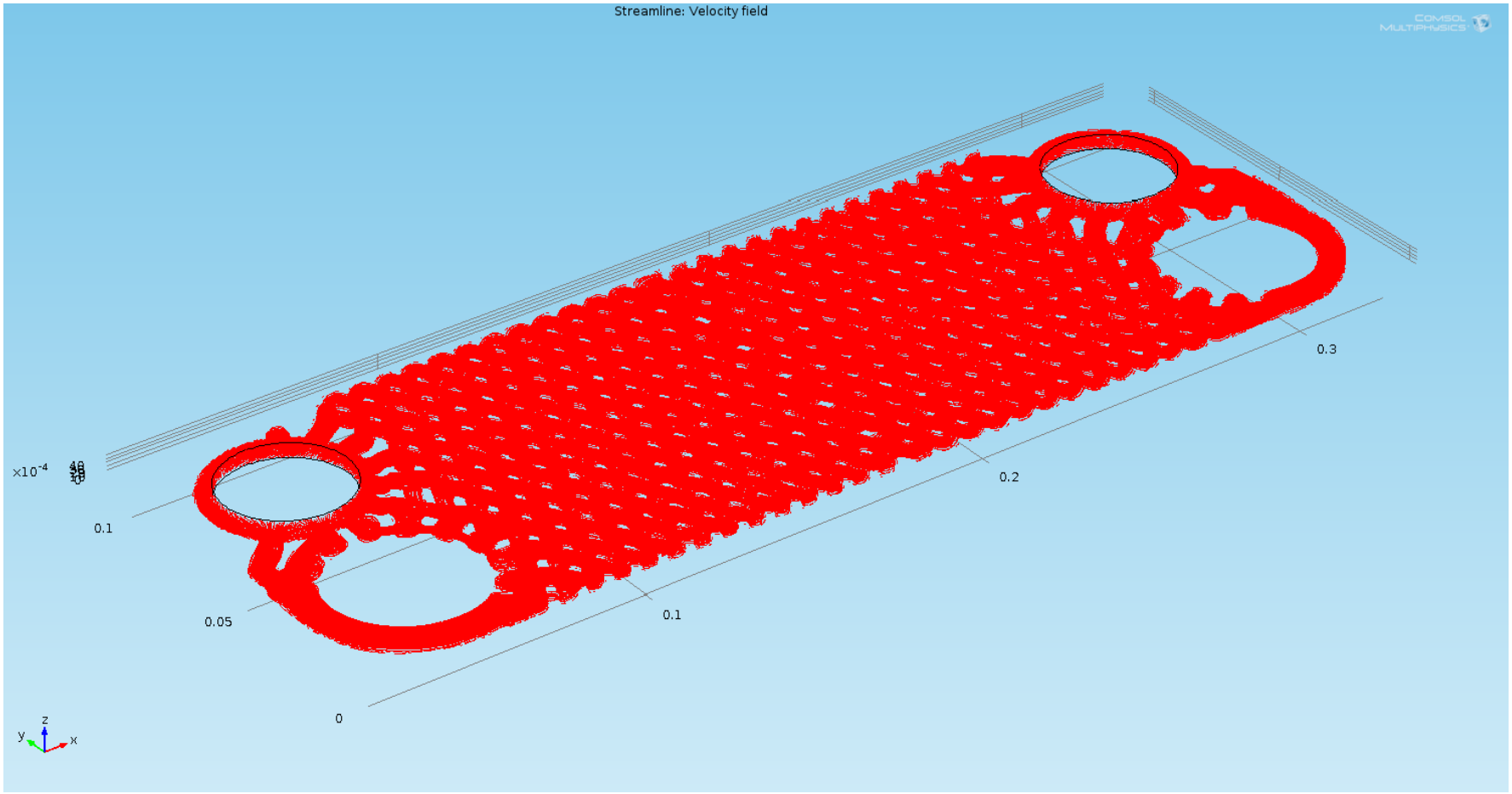
CB30 – Channel



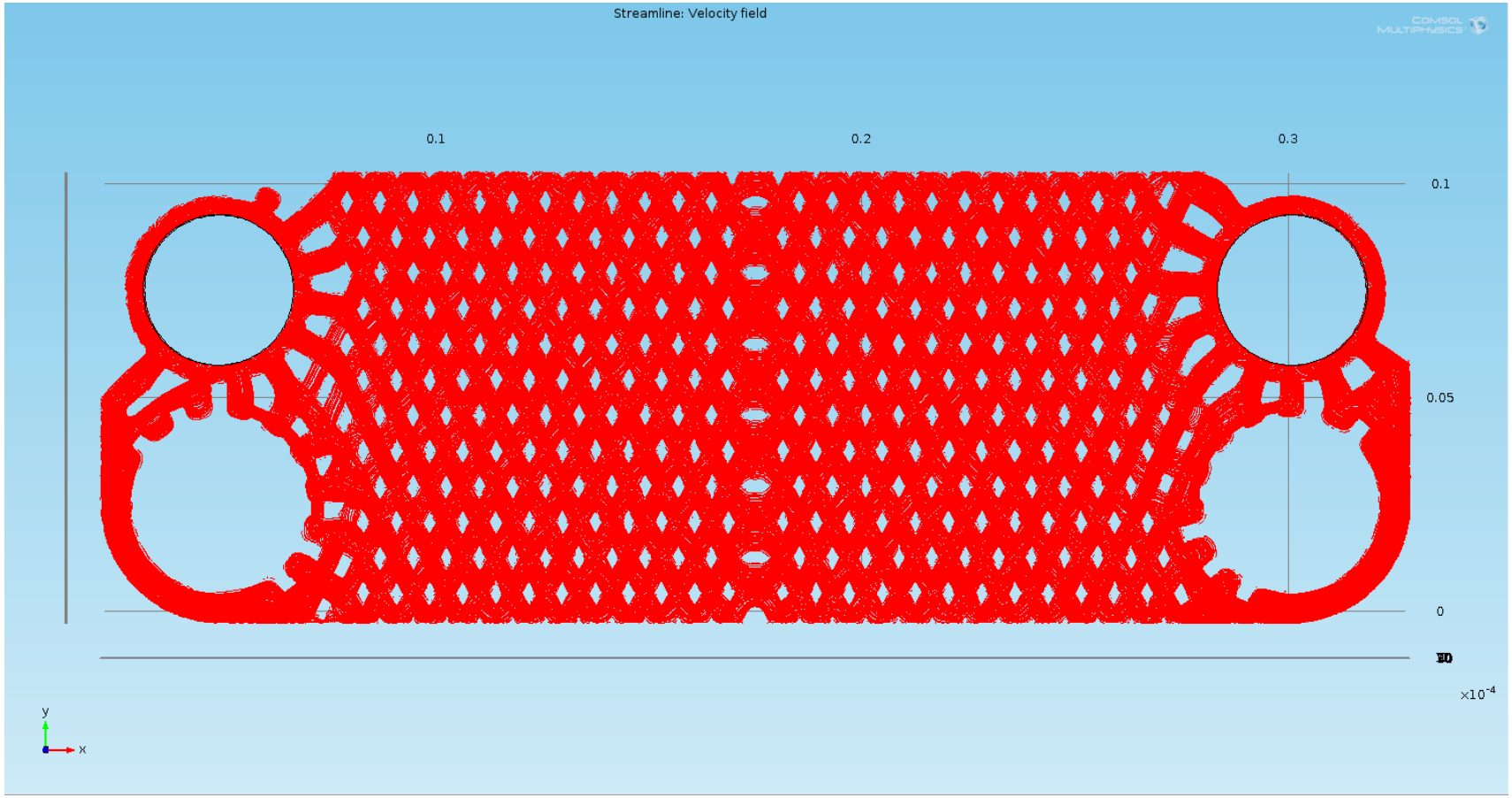
CB30 – Channel (X-Y Plane)



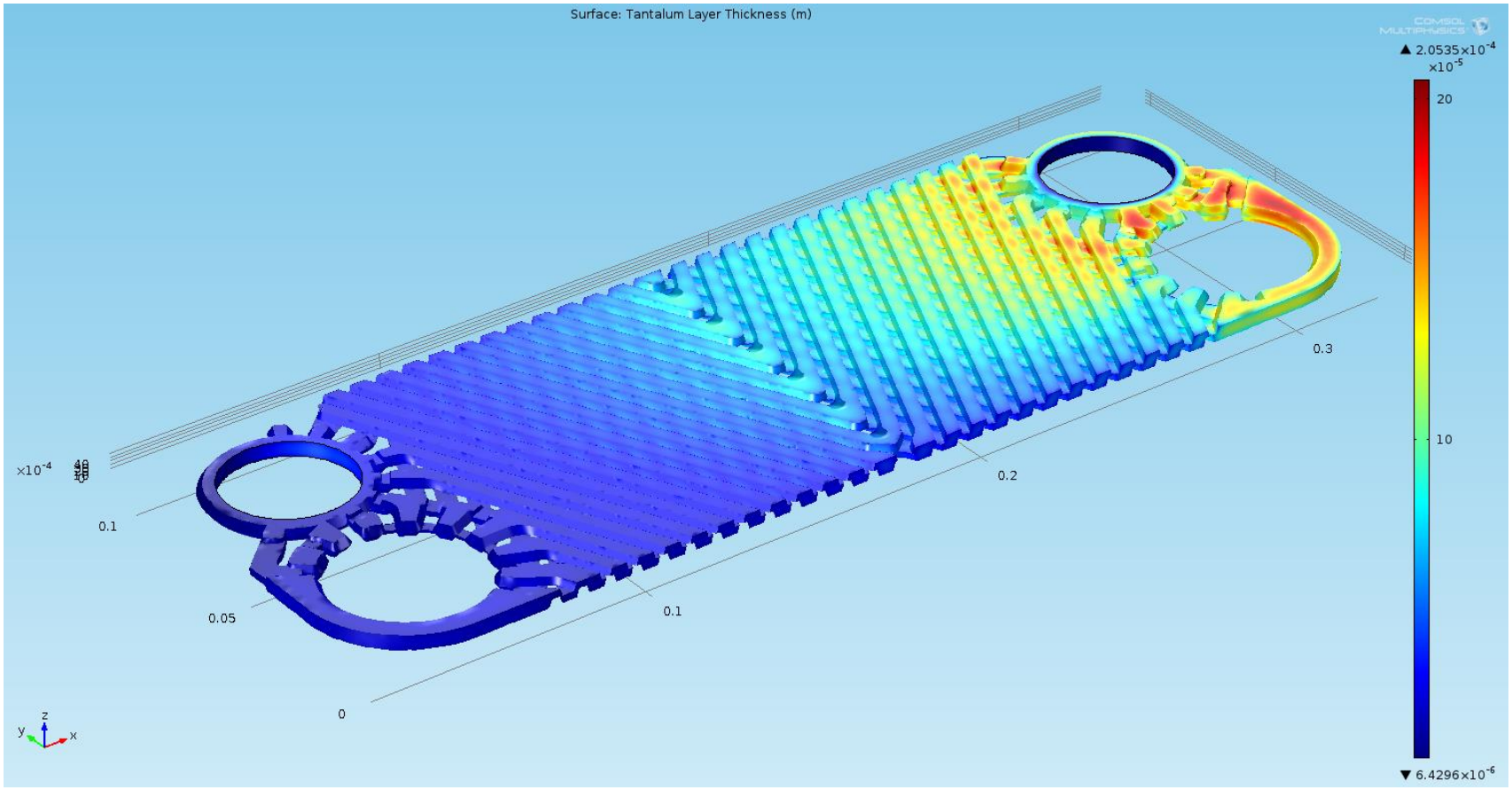
CB30 – Streamline: Velocity field Visualization



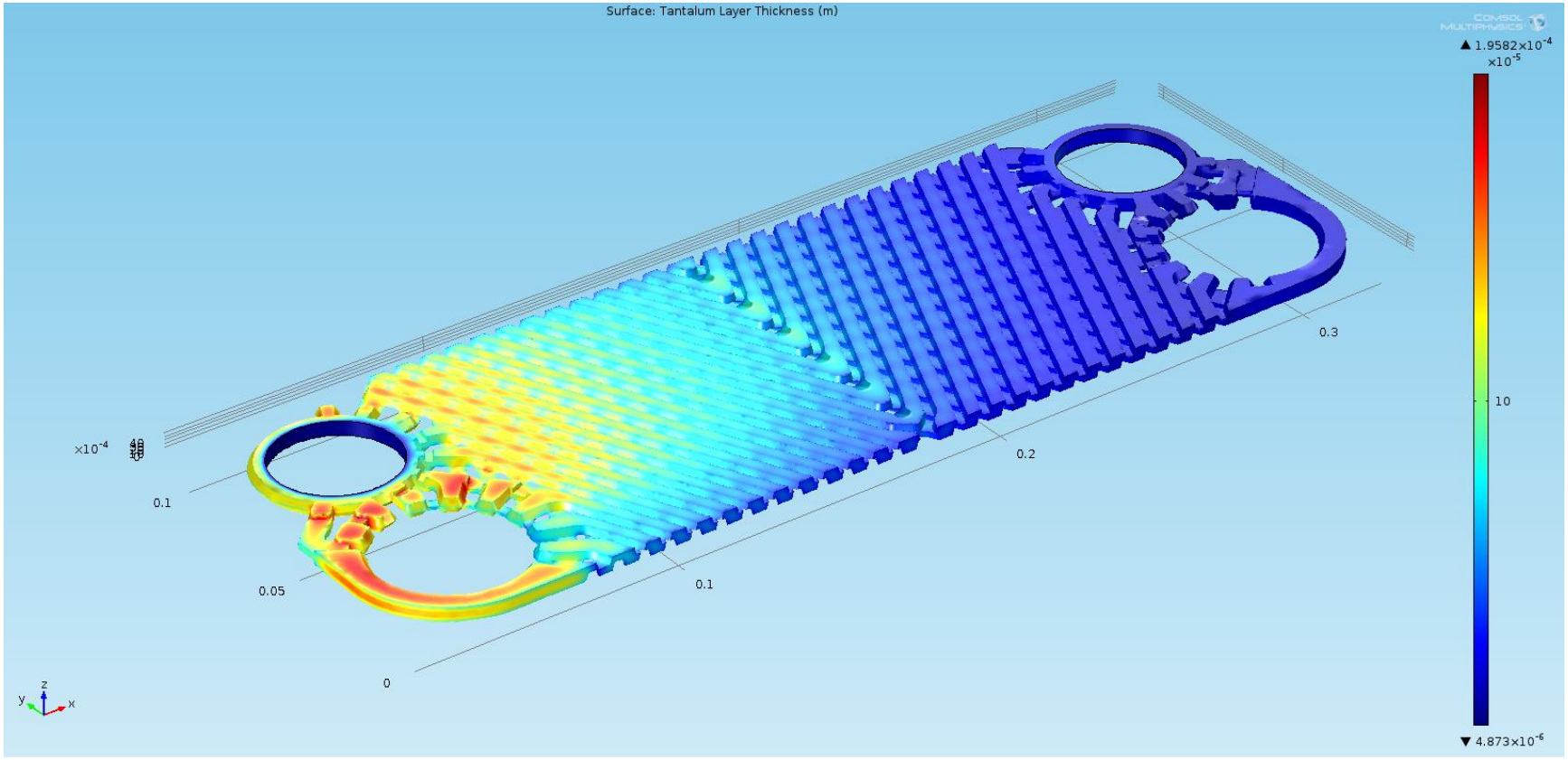
CB30 – Streamline: Velocity field Visualization



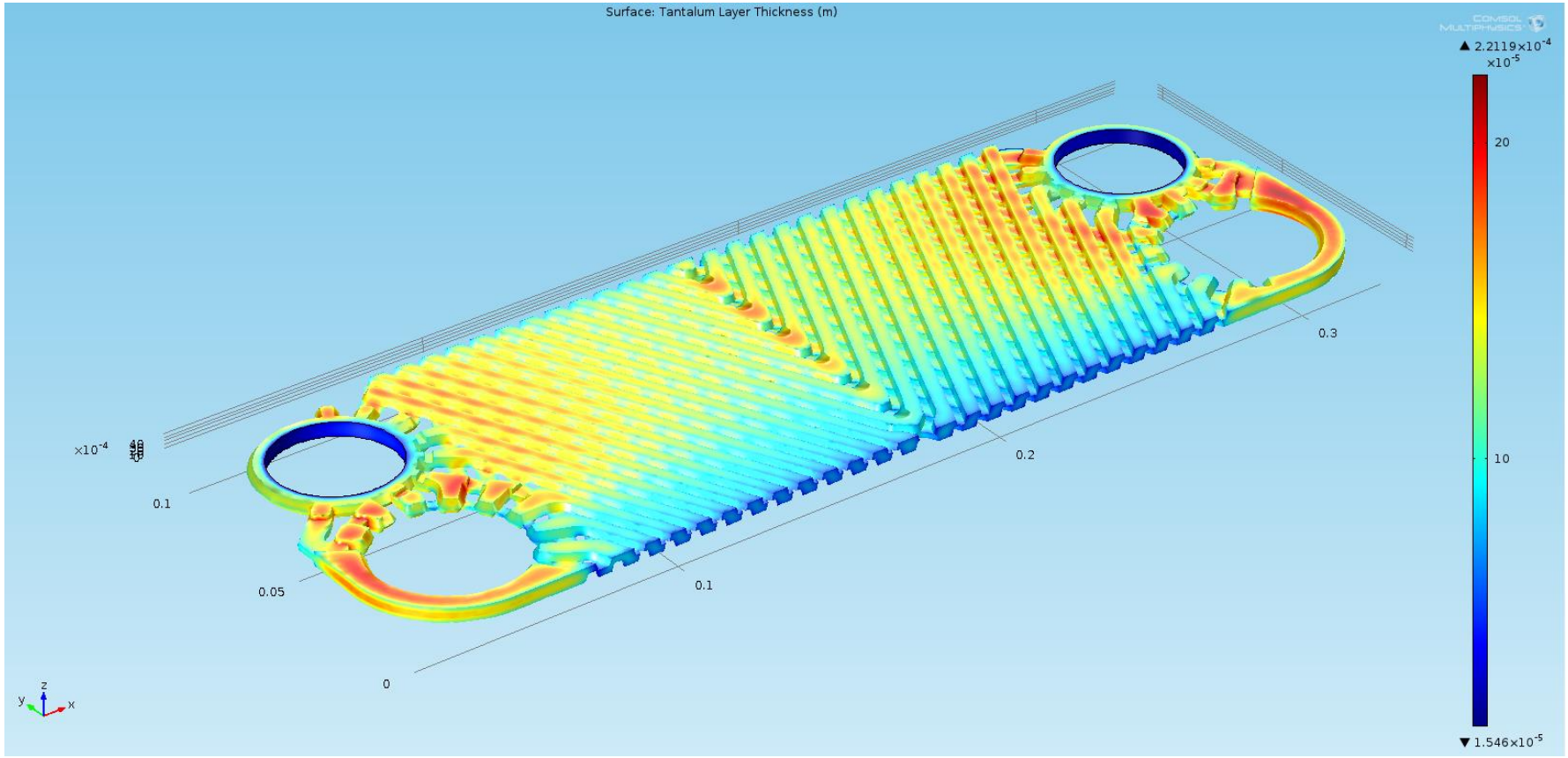
CB30 – 1st Run: Tantalum Layer Thickness
(i.e. Only treated from the right end)



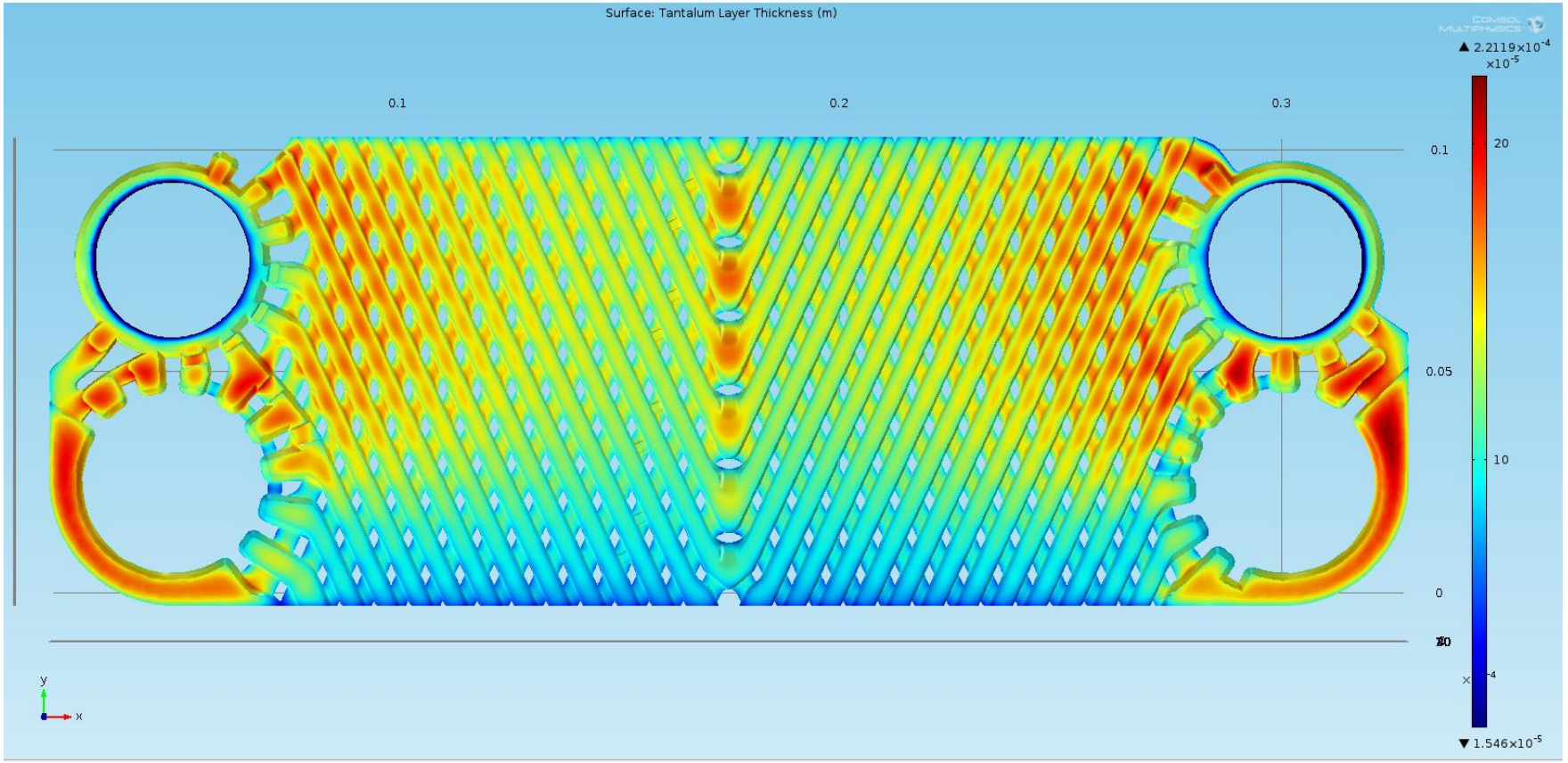
CB30 – 1st Run: Tantalum Layer Thickness
(i.e. Only treated from the left end)



CB30 – 2nd Run: Tantalum Layer Thickness
(i.e. Treated from the both ends)



CB30 – 2nd Run: Tantalum Layer Thickness
(i.e. Treated from the both ends)



Thank you for your attention.